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Psychological Bulletin

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THE

PSYCHOLOGICAL BULLETIN

A MULTIPLE UNIT SYSTEM OF MAZE CONSTRUCTION

BY R. H. STETSON AND J. F. DASHIELL

Oberlin College

The maze mode of experimentation is one that has had a great deal of use in the psychology of recent years. It may be said to have established itself pretty definitely among the methods of the laboratory. The general idea was used by Thorndike, when doing his pioneer work on animals, in the form of a simple pen or labyrinth for chicks formed of books-on-end. Small and Kinnamon did early work on animals with more elaborate mazes, particularly of the well-known Hampton Court pattern. This and other forms were used for work on various animals by Porter, Rouse, Allen, Sackett, Watson, Carr, Peterson, Vincent, Richardson, and others; and Watson and his students, including Bassett, Hubbert, and Lashley, have been using mazes built on the plan of concentric circles.

This type of apparatus has recommended itself as peculiarly well adapted for the study of habit formation in animals. In the successive trials of a subject to thread his way through the complex passage-ways to reach his goal, the time consumed in each trial, the errors or ineffective variations made, and the distance covered, are all subject to exact measurement and record. The rate of progress is thus accurately indicated, and many of the technical problems connected with learning are readily approachable (*e.g.*, correlation of rate of learning with age, with temporal distribution of trials, with species of animal used, with kinds of incentives employed, etc.). Simple mazes have also been used by Yerkes for studying sensory discriminations.

The applicability of the labyrinth method to the study of human learning came to be appreciated in time, and some of the problems

of experimental pedagogy, for instance, have been given a fresh approach thereby (Perrin, Pechstein, Webb, and others).

From the first, one characteristic has been true of all the mazes used: they have been built in more or less permanent and unchangeable form. Perhaps most have been of solid wood walls nailed to

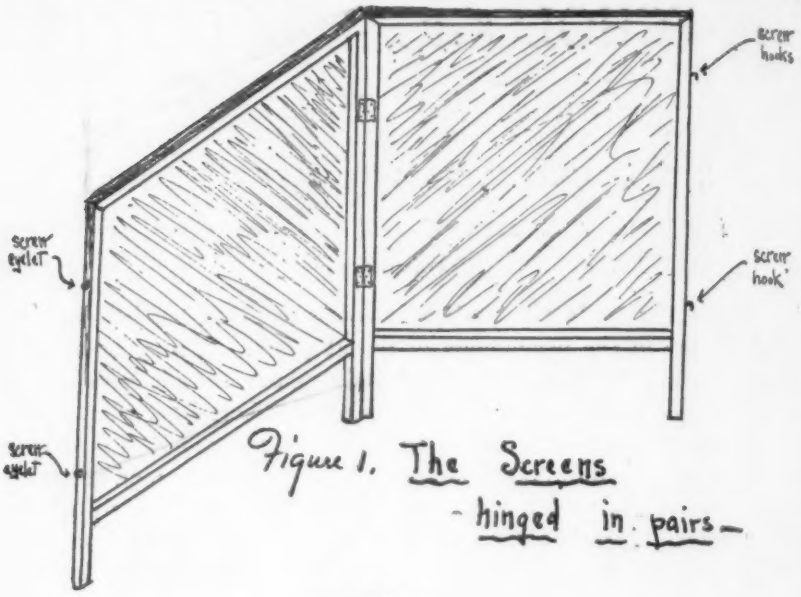

FIG. 1

the floor, some have been of wire mesh, some of solid aluminum, etc. A few investigators have introduced minor adjustable arrangements, as to change lengths of blind alleys (Peterson) or to close at will passageways from one to another part (Pechstein). But the full possibilities of the maze method were by no means exhausted as long as the apparatus was constructed completely or almost completely solid and unchangeable. The idea of setting an animal different kinds of problems in his maze learning has heretofore called for the separate construction of each pattern to be used. Besides the inconvenience, the expensiveness of using many different patterns has been an obstacle.

It is with a view to helping to meet these difficulties that the writers have developed a departure in the method of constructing mazes: what may be called a multiple unit system, whereby an indefinite number of different patterns may be built without tools

and within a few minutes for each, from a single set of materials. The idea originated with one of the authors[1] when seeking for a practicable maze in the study of kindergarten children. What was needed was a set of mazes that could be erected in any fairly large room by kindergarten teachers-in-training, could be packed away

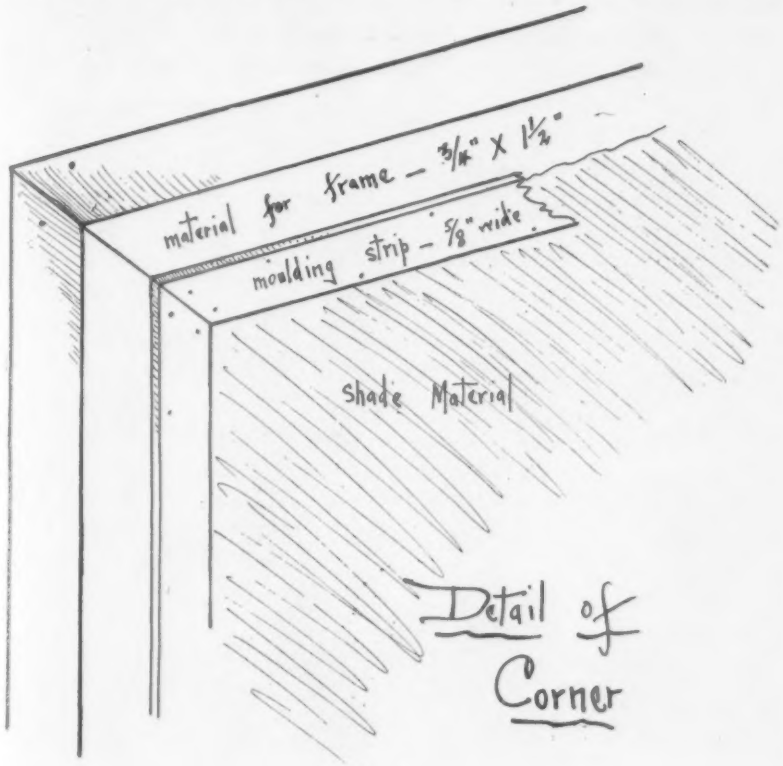

FIG. 2

in small space when not used, and could be adjustable (to study, *e.g.*, the relations of one simple habit learned to another to be learned).

The idea took the following shape. Upon a wooden frame 36″ x 44″ was mounted a nearly square piece of Holland shade material. The frame was raised from the floor upon legs 4″ long (to protect the cloth from children's shoes), making the total height 48″, and presenting an appearance not unlike a common form of household screen. At one end or side of each frame, or unit, were

[1] R. H. Stetson.

attached two screw eyelets, at the opposite end, two screw hooks. A few of the units were joined together in pairs by hinges replacing the hooks and eyelets. To erect a maze, one had only to find a floor space of suitable size; lay out his pattern on paper; and then stand up one unit at a time upon its legs, attaching it at one or both ends to other units. A partition of, say, 18 feet length would thus be constructed by successively attaching 6 units end to end, and any third partition branching off one either side would be begun by attaching a new unit at the hook-and-eyelet connection between two of the original units.

Figure 1 shows a draughtsman's sketch of units viewed as wholes, and Figure 2 shows the details of construction.

Figures 3 and 4 show photographs of the human maze material as set up in two typical ways used in the Oberlin College laboratory

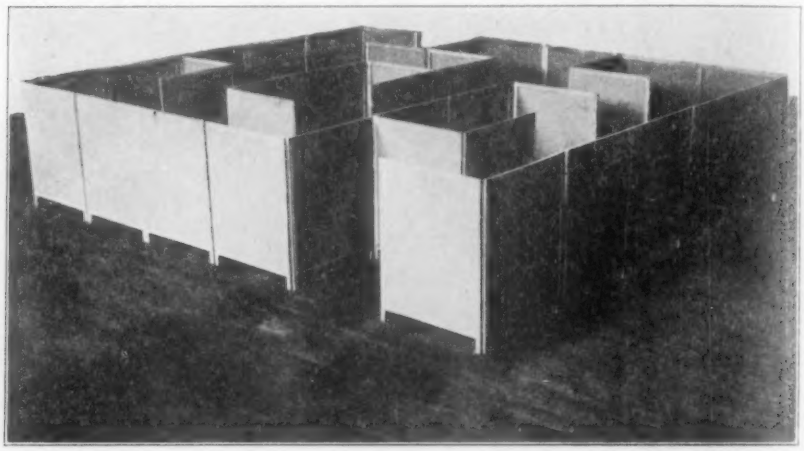

FIG. 3

and in the Oberlin Kindergarten Training School—on a rectangular plan and on an irregular plan. (The "bulging" appearance of top of maze is due to the elevation of camera.)

This set of materials has been used with children by both writers quite satisfactorily. Some of the types of problems approachable made with it will be suggested below.

The fundamental idea of the children's maze just described was found readily applicable to the study of the behavior of white rats by one of the authors.[2] The practical problem here was to find the

[2] J. F. Dashiell.

kinds of material that could be made up in a similar fashion on a much smaller scale and for a different kind of species. The solution was worked out as follows: The floor was cut from the composition cork flooring commonly used in libraries and other public buildings and mounted upon a flat wooden base. This could be made any desired size; that used here was a square 30″ x 30″. The partition units were squares 4″ x 4″ of galvanized iron with two 3′ 8″ steel

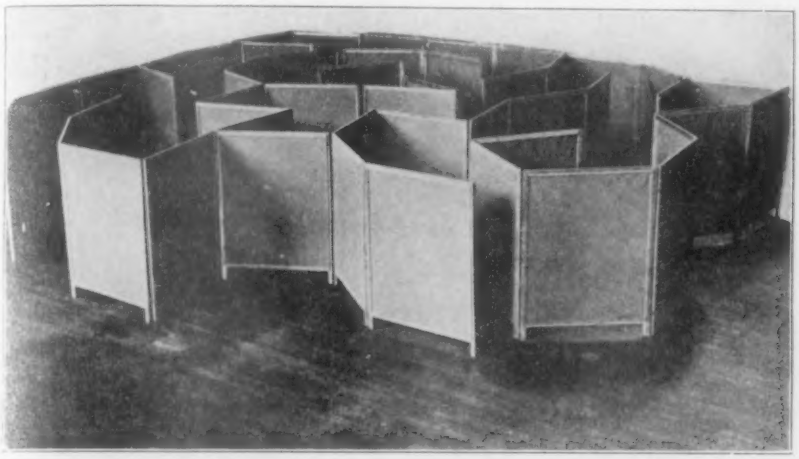

FIG. 4

points soldered into small slits on the edge to be used as the bottom. The units were easily curved in a tinner's roller for maze patterns calling for curving paths.

The assembling of a fairly complicated maze was a matter of less than thirty minutes. Light pencil lines were drawn on the cork composition flooring according to the design to be used, and the iron squares set end to end along these lines with their steel points driven easily into the floor. Extra rigidity and evenness was secured by two simple devices: round paper clips attached at the top of each end-to-end joint, and tin strips 4″ x 1″ bent at the desired angle (usually 90°) down the middle lengthwise, placed at the corners of the walls, and secured with paper clips of the sort mentioned. Over all was laid a cover of glass the size of the floor. When finally set up the maze had a surprising degree of rigidity, equal to the most violent assaults of any animal small enough to move inside—and white rats do not make violent assaults. Scep-

ticism as to whether the unpainted iron square, tin strips, or paper clips might not form disturbing elements has been dispelled by careful observations throughout several extended experiments.

Figures 5 and 6 show photographs of the animal maze material as set up in two typical ways. The rectangular arrangement is one of a great variety that have been used in the Oberlin laboratory.

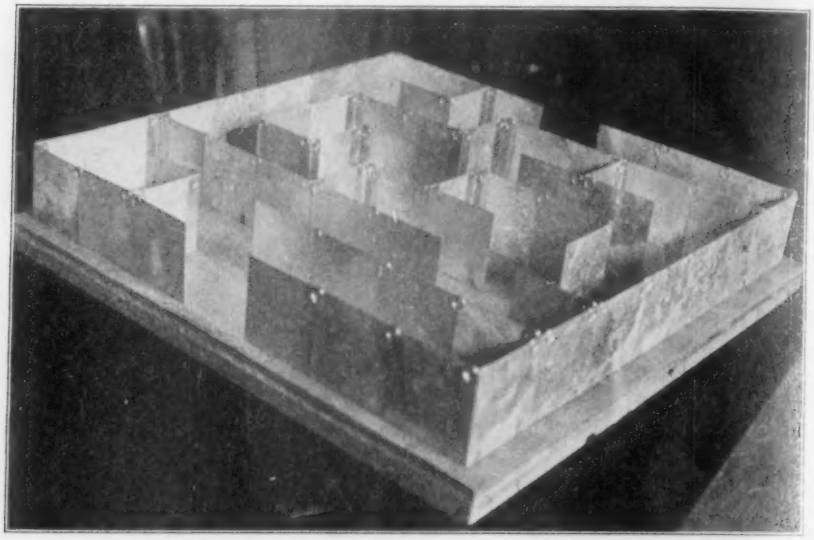

FIG. 5

The circular arrangement is an adaptation (somewhat simplified) of the type of maze developed in the Johns Hopkins laboratory. Figure 6 shows glass cover in place.

The advantages secured by use of the multiple unit system of construction are, first, economy of effort, time, and expense over the usual methods of construction of mazes; and, second, increase in range of problems approachable.

The cost of a human maze like that described should be between $1.25 and $1.50 per unit; that of the animal maze should be under $10.00 for an outfit of the dimensions described in this paper (30″ x 30″ floor and top with about 65 units and the necessary clips and corner pieces). Either set of maze material is to be readily made up by a good cabinet maker or tinner.

To elaborate the second point somewhat:

1. Comparative studies of the learning processes of animal and

human subjects have recently been made by Hamilton, Hunter, and Yerkes with other than maze apparatus, and by Hicks, Perrin, Pechstein, Webb, and others with mazes; but the writers believe that more completely comparable maze situations than those of the latter are provided by using the multiple unit forms. Some comparative observations on white rats and kindergarten children have been made in the Oberlin College laboratory and in the Oberlin Kindergarten Training School that may be extended and published in the future.

2. The readiness with which all parts of the mazes can at any time be redistributed without change of pattern, offers excellent opportunities for isolating and checking many of the subtle factors that may or may not operate in maze running; especially incidental sensory elements such as visual cues in human and olfactory and visual cues in animal learning. Some attention has been given to

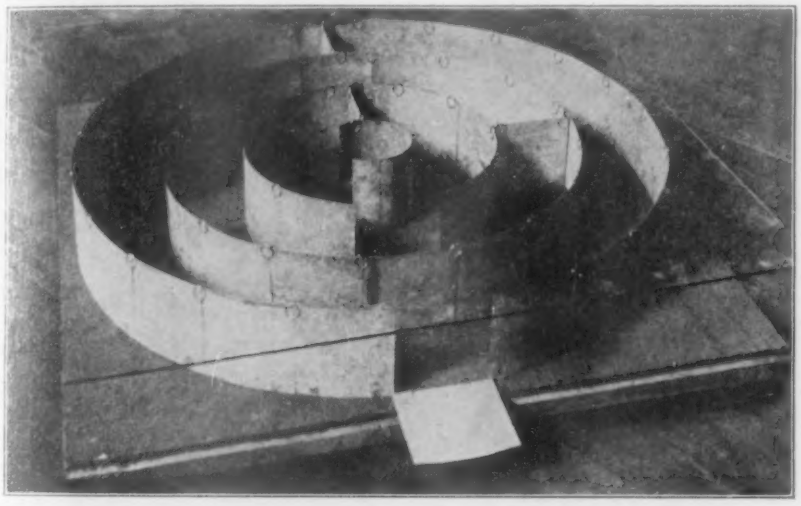

FIG. 6

these possibilities by the writers. In a preliminary way it may be stated that frequent 'shuffling' and redistribution of maze parts tends to show that such sensory cues as those just mentioned play a surprisingly little part in the learning of a maze.

3. The readiness with which the patterns of the mazes can be rearranged suggests at once a fuller opportunity for the study of the inter-relations between different processes of habit formations

than has yet been had. Results of experiments on transfer factors between habits and on comparison of two different modes of learning a given pair of mazes are about to be published.

4. The facility with which multiple unit mazes can be altered indefinitely in a few minutes has opened up a field of quite new problems—an intensive study of the many elements and details involved in the lay-out of a maze stiuation. Publication is to be made shortly of studies carried on in the Oberlin laboratory of the comparative values of different arrangements of cul-de-sacs.

It may be noted in closing that the writers are at present working on further extensions of the multiple unit idea: to the construction of a pencil maze for experimentation on adults, and to the construction of a tri-dimensional maze for the study of the behavior of rats in a more complicated situation than is afforded by labyrinths built upon the one plane only.

TWO MODELS SHOWING THE INTERRELATION OF SEVERAL SIGNIFICANT CORRELATION VARIABLES[1]

BY ARTHUR W. KORNHAUSER, FRANKLYN MEINE, AND BEARDSLEY RUML,

Carnegie Institute of Technology

With the strong impetus which mental testing has received during the past year or two, the importance of correlation as a psychological instrument has become more commonly recognized than ever before. At the same time, students of statistical method appreciate the dangers involved in the widespread use of correlation coefficients by those who have not sufficiently mastered the significance and limitations of '*r*' which do not appear from the mere use of a handy formula. Our psychological literature contains no end of studies, for example, where thoroughly unjustified conclusions are drawn on the basis of the correlation coefficients alone, no mention being made of the probable error of *r*, of the standard deviations of the variables, of the regression equations, of the standard error of estimation, or even of the precise nature of the group measured. Correlations obtained on heterogeneous material are used for predicting relationship in more homogeneous

[1] The models here presented were constructed in connection with a course in biometric methods given by Dr. Beardsley Ruml at Carnegie Institute of Technology.

material; equal correlation coefficients are presumed to indicate equal relationship without respect to the distribution of the variables involved. In order to make a little more clear the complexity of r and the wide possibilities of variations not depicted by it alone, we have considered it worth while constructing two models of the important variables involved.

Model A

Showing Types of Frequency Surfaces and the Meaning of r, σ_x, and s_x.

The model (Plate I.) represents a scatter diagram in three dimensions. The X-arrays (rows) are shown as small frequency surfaces. The sum of all such partial frequency curves is the

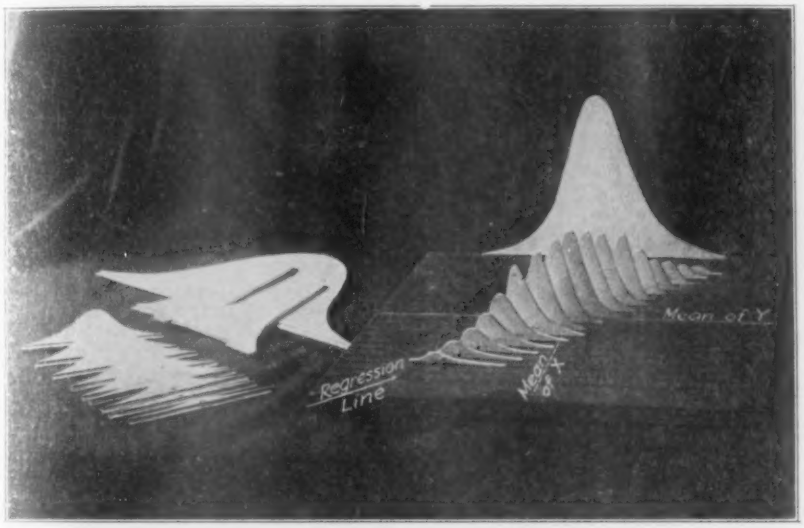

Fig. 1

total X-distribution and is shown as the large frequency surface at the top of the model. Evidently the Y-distribution is a surface in which each interval has the frequency of that particular array of X's. Only one regression line ($X = b_{xy}Y$) is shown and we shall assume in this discussion that the relation dealt with is that of X to Y rather than the reverse. As its most general function the model enables one to appreciate vividly the nature of a correlation table as a three-dimensional relation.

When set with any particular combination of curves the model represents a specific contingency table or frequency surface. The precise shape of this surface may be varied ad infinitum so that it may be made to approximate any contingency distribution actually encountered. The model, in addition to the general aid it gives in understanding the contingency relation, is of value in two directions: (1) it illustrates the innumerable possibilities of frequency surfaces and shows the special significance of each; (2) it indicates the interdependent changes in the values of the three variables—r, σ_x, and s_x.

1. As the model is now arranged the Y-variable is assumed to be distributed in the form of the normal curve and the X-variable in the form shown by the large curve of the total X-distribution. The small curves represent the distribution of X-values for the particular arrays indicated. The following properties may be noted in this regression: the means of the arrays (small curves) fall along a straight line (linear); the standard deviation or σ of the arrays does not change (homoscedastic); some of the array curves are skewed (allikurtic); the skewness is not equal throughout, some arrays being skewed positively and some negatively (heteroclitic); the change in skewness is continuous or regular (nomic). In a similar manner any regression may be completely described.[1]

It should be noted that strictly speaking we have not fully described any correlation surface without all these items. Practically, of course, such procedure is ordinarily out of the question. The important point, however, is that we recognize the existence of this tremendous complexity and do, in view of these facts, exercise the utmost caution in drawing general conclusions from correlation figures. The fact, for example, that we do not care to sacrifice the time necessary to apply a test for linearity in the case of every regression does not mean that we should not be ever on the alert to avoid incorrect inferences as to the degree of relationship and reliability of prediction due to unjustified assumptions of linearity. The same applies of course, to all the other less clearly recognized variations in contingency tables.

2. The three important variables mentioned (r, σ_x, and s_x) are easily explained from the model. The rod passing through the

[1] The corresponding opposites of the terms here used are: non-linear, heteroscedastic, isokurtic, homoclitic, and anomic. The terminology is that of Pearson (Draper's Company Research Memoirs, Biometric Series II., 1905).

mean points of all the small array-curves represents the regression line. The slope of this line to the Y-axis is the regression coefficient, b_{xy}. r bears the simple relation to b_{xy} expressed by the equation $b_{xy} = \sigma_x/\sigma_y\, r$. σ_x is seen directly as the standard deviation of the large curve at the back of the model. s_x is the weighted average of the standard deviations of the array-curves. s_x is known as the standard error of estimation of X-values. It is readily derived from the formula $s_x = \sigma_x \sqrt{1 - r^2}$. This standard error of estimation is a kind of average of the standard deviations of all the rows of X-values and hence in the usual case of frequency surfaces of more or less uniform scatter it is roughly equal to the standard deviation of each array (each small curve in the model). s_x is the standard deviation of $(X - b_{xy}Y)$, *i.e.*, the standard deviation of the distances of the true X's from the predicted X's. The standard error, represented by E, is a pure number and is simply the ratio of s_x to σ_x or of s_y to σ_y, *i.e.*, $E = \sqrt{1 - r^2}$.

The interdependent changes in these variables may be observed in the model.[2]

By keeping constant any one of the three variables involved we may readily note the relation of changes in the other two. (σ_y is also constant, of course, by the nature of the model.) For example, if the standard error of estimation (s_x) remains constant it may at once be seen that increasing the scatter of the X-variable (σ_x) necessitates a corresponding increase of r by revolving the regression line away from the Y-axis. Similarly, if the standard deviation of the X-variable remains constant, it is evident that decreasing r (revolving the regression line toward the Y-axis, that is) necessitates increasing the scatter in the arrays, *i.e.*, increasing the standard error of estimation. For constant r, finally, note that the larger the standard deviation of the total distribution the larger the standard error. The model enables one by changing these variables to note their interrelations under various conditions of linearity, scatter, and so on. The quantitative relation of the variations is not shown, however, in this model.

Model B

The Relation of the Variables r, σ_x, and s_x

The model (Plate II) is a three-dimensional graph of the formula, $s_x = \sigma_x \sqrt{1 - r^2}$. r is measured to the right and left from zero at the center; σ_x is measured from front to rear; s_x is measured vertically upward.

[2] The mathematical relations are shown graphically in Model B.

The surface for constant r, seen by passing a vertical plane perpendicular to the back of the model, is perhaps the most obvious and least interesting. The relation is linear, indicating that increase in σ_x is accompanied by a proportional increase in s_x.

The surface for constant σ_x, any vertical plane parallel to the one formed by the back of the model, is more important. This indicates that as r decreases from + 1.0 or increases from − 1.0, the standard error increases with extreme rapidity. Concretely, when r is equal to .86, the standard error is half as great as it ever will be; when r equals .50, the standard error is seven-eighths its maximum size. The amount of error made in predicting from the regression equation on the basis of a correlation of .44 is nine tenths

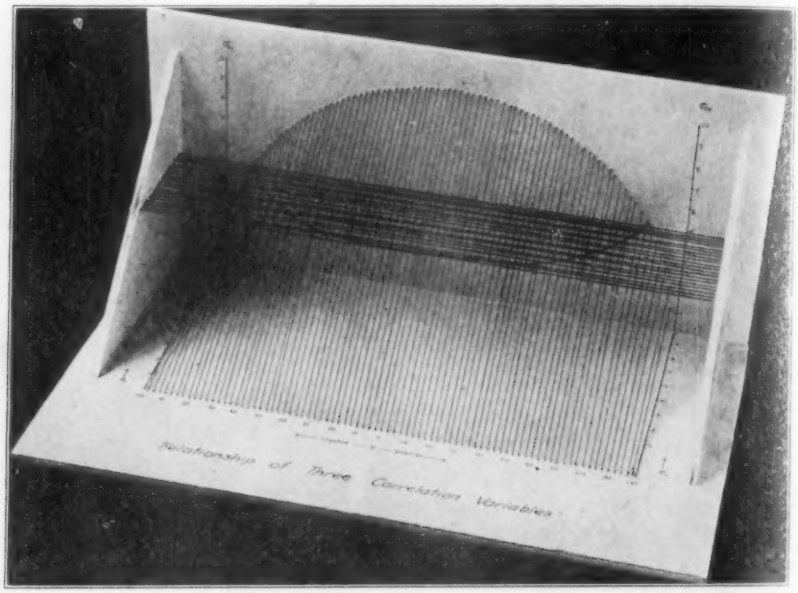

FIG. 2.

as great as the error made in guessing on the basis of no information whatever. The relation, as seen on the back of the model, is a semicircle if σ_x be measured in terms of s_x.

The surface for constant s_x, any horizontal plane such as the one shown (red in the actual model), is also of great importance. If the error of estimation be constant, as it is in homoscedastic regressions, r will change markedly with slight changes in σ_x, the

increase being most striking for those values of σ_x slightly larger than s_x. Concretely, when $\sigma_x = s_x$, $r = 0.0$; when σ_x is increased from this value by one tenth, r is increased from 0.0 to .45. Thus with a constant standard error of estimation, the correlation coefficient increases with the standard deviation of the group and approaches 1.00 as a limit when σ_x approaches infinity. The relation is parabolic.

A SCORING METHOD FOR MENTAL TESTS

BY L. L. THURSTONE

Carnegie Institute of Technology

Much has been said about the weighting of a series of mental tests so as to obtain the highest possible correlation between a criterion and a group of tests. This is accomplished by multiple correlation. Now, why should we not apply the same technique in ascertaining how much to penalize for errors in a single test in order to obtain the highest correlation with the criterion? How many mental test correlations could have been raised if the test had been scored in some other way?

Let us consider the number of right responses and the number of wrong responses as two independent variables which are to be weighted to obtain the dependent variable, the score. The weighting should be such that the score will give the highest possible correlation with the criterion. This is our problem.

We shall work with the general scoring formula $S = R + CW$, in which S is the score, R is the number of right responses, W is the number of wrong responses, and C is a constant which determines how much we shall penalize for errors. The constant C is usually negative.

Our first problem is to obtain a general expression for the correlation between the test score and the criterion. In other words we want to express the correlation $r_{I(R+CW)}$ between the criterion I and the score $(R + CW)$ in terms of the six fundamental constants which we shall assume to be given, namely r_{IR}, r_{IW}, r_{RW}, σ_R, σ_W, σ_I.

Remember that

$$r_{xy} = \frac{\Sigma xy}{n \cdot \sigma_x \cdot \sigma_y}.$$

Therefore

$$r_{I(R+CW)} = \frac{\Sigma I(R + CW)}{n \cdot \sigma_I \cdot \sigma_{(R+CW)}}$$

$$= \frac{\Sigma IR + C\Sigma IW}{n \cdot \sigma_I \cdot \sigma_{(R+CW)}}$$

$$= \frac{n \cdot r_{IR} \cdot \sigma_I \cdot \sigma_R + C \cdot n \cdot r_{IW} \cdot \sigma_I \cdot \sigma_W}{n \cdot \sigma_I \cdot \sigma_{(R+CW)}}$$

$$= \frac{r_{IR} \cdot \sigma_R + C \cdot r_{IW} \cdot \sigma_W}{\sigma_{(R+CW)}}.$$

But since

$$\sigma_{(R+CW)} = \sqrt{\frac{\Sigma(R + CW)^2}{n}}$$

$$= \sqrt{\sigma_R^2 + 2 \cdot C \cdot r_{RW} \cdot \sigma_R \cdot \sigma_W + C^2 \cdot \sigma_W^2}$$

we have

$$r_{I(R+CW)} = \frac{r_{IR} \cdot \sigma_R + C \cdot r_{IW} \cdot \sigma_W}{\sqrt{\sigma_R^2 + 2 \cdot C \cdot r_{RW} \cdot \sigma_R \cdot \sigma_W + C^2 \cdot \sigma_W^2}}, \qquad (1)$$

which is the relation sought.

Equation 1 is the equation of the curve in the accompanying figure.[1] This equation enables us to determine just what correlation we should have for any specified weighting of C. Suppose that we have the six fundamental constants enumerated above and that we give one point credit for each correct response and penalize 1/2 point for each error. We should then be using the scoring formula $S = R - 1/2\ W$ in which the constant C has the numerical value $-1/2$. Substitute the value for C together with the other six constants in equation 1 and determine the correlation with the criterion. This saves us the labor of rescoring all the test papers and it saves us the trouble of calculating the extra coefficient.

In order to show the effect of different methods of scoring a test I have plotted equation 1 for the Number Completion test which is similar to one of the tests in the Army Alpha. I gave this test among many others to the freshman class at the Margaret Morrison School for Women at Carnegie Institute of Technology in November, 1917. The criterion against which the test was correlated in this case was the pooled instructors' estimates of the stu-

[1] I am indebted to Professor T. L. Kelley for valuable hints in deriving equation 1.

dents. The six fundamental constants for the Number Completion test are:

$$r_{IR} = +.40, \qquad \sigma_I = 2.10,$$
$$r_{IW} = -.10, \qquad \sigma_R = 3.19,$$
$$r_{RW} = -.51, \qquad \sigma_W = 3.28.$$

If we substitute different values for C in equation 1 we soon find that the correlation between the criterion and this test is very seriously affected by assuming a scoring method at random. I dare

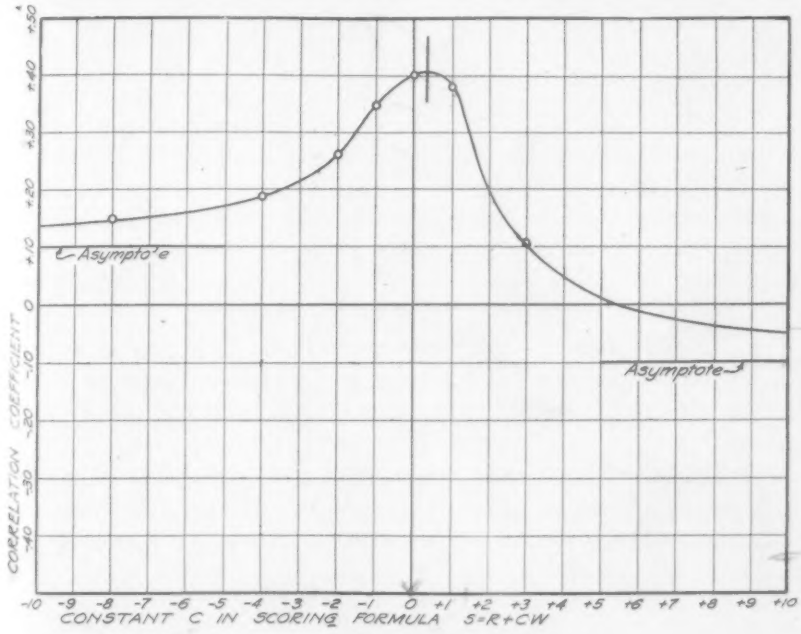

FIG. 1

say that many good tests have been discarded as useless owing to the unfortunate scoring method guessed at and adopted by the investigator.

Our next problem is to ascertain the scoring method which gives the highest correlation with the criterion. This is answered by finding that value for C at which $r_{I(R+CW)}$ becomes a maximum.

If we find the first derivative of $r_{I(R+CW)}$ in equation 1 with respect to C, equate it to zero, and solve for C we have

$$C = \frac{\sigma_R(r_{IR} \cdot r_{RW} - r_{IW})}{\sigma_W(r_{IW} \cdot r_{RW} - r_{IR})}. \qquad (2)$$

This is a practical formula by which we may determine how to score our tests. Substitute the numerical value of C as found by this formula in the general scoring formula $S = R + CW$. If we determine our scoring method by equation 2 we shall be certain that we have selected the best possible scoring method for the test. If the test fails, the failure is not due to the scoring method. This assumes, of course, that the best scoring formula is of a linear form. Applying equation 2 to the Number Completion Test reveals the fact that it should be scored $S = R + 0.4\ W$. In other words, we should allow some partial credit for each mistake instead of penalizing for errors. Speed in this test is apparently a significant factor although not as important, of course, as accurate speed.

Now suppose that we have determined our best scoring formula and find it to be, say, $S = R + 0.4\ W$. Our next problem is to ascertain how much the correlation $r_{I(R+CW)}$ would be affected if we should use an approximation such as $S = R + 1/2\ W$. If a test is extensively used we might prepare a table with two coordinates, R and W, and with the score S inserted in the squares of the table, thus avoiding calculation for each test paper. But if we calculate the score for each subject we should know the relative degree of sensitiveness of the scoring method. One obvious answer is to inspect the curve. If the slopes of the curve are steep on either side of the maximum ordinate the scoring is sensitive, otherwise it is not.

It is of some interest to ascertain at what numerical value of C the correlation $r_{I(R+CW)}$ becomes zero, especially since the calculation is easily made. From equation 1 we see that $r_{I(R+CW)}$ becomes zero when

$$r_{IR} \cdot \sigma_R + C \cdot r_{IW} \cdot \sigma_W = 0.$$

This condition obtains when

$$C = \frac{-\ r_{IR} \cdot \sigma_R}{r_{IW} \cdot \sigma_W}. \tag{3}$$

Let us consider a practical application of equation 3. One of our best mental tests for adults is a syllogism test. It is best scored $S = R - 1.63\ W$ as standardized on high-school seniors. Now suppose that we should score this test only on the basis of speed, *i.e.*, the amount done in unit time. This is equivalent to the scoring formula $S = R + W$ in which C is assumed to be unity. The six fundamental constants are:

$$r_{IR} = -0.21, \qquad \sigma_I = 1.73,$$
$$r_{RW} = +0.08, \qquad \sigma_R = 2.87,$$
$$r_{IW} = +0.29, \qquad \sigma_W = 2.31,$$

Solving for C in equation 3 we find that the correlation $r_{I(R+CW)}$ is zero when the constant C is $+0.9$ which is dangerously near the value of C in the above assumption. Hence we conclude without even calculating the coefficient $r_{I(R+CW)}$ that it will be close to zero, but this should not justify discarding the test until the most advantageous value of C has been determined by equation 2.

When the best scoring method has been ascertained by equation 2 we want to know what correlation the test will yield if we do use the best scoring method. This can be ascertained by the standard equations of multiple correlation for three variables. Writing Yule's equation with our present notation we have

$$R_{I(R+CW)} = \sqrt{1 - (1 - r_{IR}^2)\,(1 - r_{I(CW)\cdot R}^2)}$$

in which $r_{I(CW)\cdot R}$ is a coefficient of the first order. Substituting the best value of C for equation 2 in the above equation and remembering that $r_{I(CW)}$ is identical with r_{IW} since C is a constant, we have

$$R_{I(R+CW)} = \sqrt{\frac{r_{IR}^2 + r_{IW}^2 - 2\cdot r_{IW}\cdot r_{IR}\cdot r_{RW}}{1 - r_{RW}^2}}, \qquad (4)$$

which gives the highest correlation obtainable with a linear scoring formula. Equation 4 gives exactly the same value for $R_{I(R+CW)}$ as is obtained by the more usual multiple correlation formulæ. Its advantage is in being expressed in terms of the six fundamental constants with which we start.

The asymptotes of the curve are of some statistical interest. When the constant C becomes infinite the correlation between the test score and the criterion becomes identical with the correlation r_{IW}. Since the correlation between errors and the criterion is usually negative the curve is usually asymptotic to a horizontal line at the negative value of the correlation r_{IW}. When the constant C becomes minus infinity the score is proportional to $-W$. Since the correlation between the criterion and errors is usually negative, the correlation between the criterion and the score with the constant C taken as minus infinity, is positive. Hence the curve is usually asymptotic on the negative side of C to a horizontal line at the positive value of the correlation coefficient r_{IW} with its sign reversed.

The curve may be constructed roughly on the basis of the three fundamental correlation coefficients. The y-intercept is the correlation r_{IR}. The maximum ordinate of the curve is easily ascertained from equation 4. The value of C at this maximum ordinate of the curve is ascertained from equation 2. The asymptote on the positive side of C is the correlation coefficient r_{IW}. This is usually negative. The asymptote of the curve on the negative side of the constant C is the correlation coefficient r_{IW} with its sign reversed. This is usually positive. The x-intercept is determined by the equation 3. This procedure gives five significant points on the curve from which it may be sketched.

PARTIAL CORRELATIONS ON A SLIDE RULE

BY HAROLD E. BURTT

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The writer was recently surprised to find that he could compute partial correlations with a ten-inch slide rule as rapidly and as accurately as with Kelley's tables.[1] The formula most used in such computation is of the form:

$$r_{12\cdot 3} = \frac{r_{12} - r_{13}r_{23}}{\sqrt{1 - r_{13}^2}\sqrt{1 - r_{23}^2}},$$

which gives the correlation between variables 1 and 2 with the effect of variable 3 eliminated. The formula for coefficients of higher order such as $r_{12\cdot 345}$ is in exactly this form and the method and labor of solving the fraction does not depend at all on the order of coefficients involved. Kelley divides the fraction into two parts:

$$r_{12\cdot 3} = r_{12}\frac{1}{\sqrt{1 - r_{13}^2}\sqrt{1 - r_{23}^2}} - \frac{r_{13}r_{23}}{\sqrt{1 - r_{13}^2}\sqrt{1 - r_{23}^2}}.$$

He designates the fractional part of the first term by **A** and the second term by **B** and in the tables gives these **A** and **B** values for all pairs of two-place decimals from .00 to 1.00. After the three coefficients that enter into a given formula are found (either from original data of zero order or partial coefficients of order lower than the one to be computed) it is necessary to look up in the tables the

[1] KELLEY, T. L. "Tables : To Facilitate the Calculation of Partial Coefficients of Correlation and Regression Equations." *Bull. of the Univ. of Texas*, 1916.

value of A corresponding to two of them, multiply by the third and subtract the corresponding B value. The answer is usually taken to the nearest two decimal places and used in the determination of other coefficients of the next higher order. The work of any considerable interpolation in the tables is prohibitive and probably unnecessary.

In the slide rule method it is first necessary to make a table of vaiues of $\sqrt{1 - r^2}$ as r varies from .00 to 1.00. Such a table is glven in Kelley's monograph but one can be made in less than an hou reither by reading the double scale of a slide rule backwards and then taking the root of the result on the rule or by the use of 4-place logarithms. The latter procedure is preferable as it gives the third decimal place more accurately. This table of values of $\sqrt{1 - r^2}$ once made, can be used for all subsequent work. A "polyphase" slide rule, *i.e.*, one with the inverted scale on the slide facilitates the work. For convenience of reference the common lettering of such rules is adopted below, viz., D is the lowest scale on the rule, C the scale on the slide contiguous to D, CI the inverted scale on the slide, A the upper double scale on the rule and B the double scale on the slide contiguous to A.

The same formula that forms the basis of Kelley's tables is employed. For illustrative purposes the subscripts given in the above example will be used. The two coefficients that appear in the denominator, r_{13} and r_{23}, are looked up in the table of $\sqrt{1 - r^2}$ and 1 divided by the product of the two numbers found, with the slide projecting from the left end of the rule, *i.e.*, $\sqrt{1 - r_{13}^2}$ on C is set to the left end of D, the runner set to the right end of C and then $\sqrt{1 - r_{23}^2}$ on C set to the runner. It would have been possible, though not quite as accurate to make the table for $1 - r^2$ and use these values on B instead of the $\sqrt{1 - r^2}$ values on C. The right end of C is now over a number on D which is the same as the **A** value of Kelley's tables. It is usually 1 followed by a decimal. The runner is set to this and it is multiplied by r_{12} preferably by setting r_{12} on CI to the runner and reading on D below the end of the slide. This number is generally a little larger than r_{12} and is written down on paper. The runner is still at

$$\frac{1}{\sqrt{1 - r_{13}^2}\,\sqrt{1 - r_{23}^2}}$$

on D. This has to be multiplied by $r_{13}r_{23}$ and can be most easily

done by setting r_{13} on *CI* to the runner. The slide is then very often in such a position that below r_{23} on *C* the answer can be read directly on *D*. If such is not the case the runner must be set to the end of the slide, r_{23} on *CI* set to the runner and the answer read on *D* below the end of the slide. This gives the **B** of Kelley's tables and is to be subtracted from the **A** already written down and the answer taken to the nearest two decimal places.

The signs are of concern only in the numerator of the fraction and their algebraic treatment is perfectly simple. As to the decimal point in *B* it is merely necessary to remember that *B* is approximately the product of r_{13} r_{23} and with a little practice one can locate the point directly from the setting of the slide.

The writer has used the method and also Kelley's tables quite extensively and there is very little difference either in the speed or the accuracy. In a typical group of 10 coefficients one method took 9 minutes and 10 seconds and the other 9 minutes and 20 seconds, with the same results in both cases. The slide rule does not appear noticeably more fatiguing than the use of the tables. The writer uses it frequently in checking over work done with the tables. One who does not have access to Kelley's monograph and who is skilled in the use of the slide rule need not be daunted by partial correlations.

TASTE SENSATIONS FROM UTERINE STIMULI

BY HOWARD C. WARREN

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A patient who has been receiving electric treatment for a uterine tumor reports to the writer that she had a distinct metallic taste in the mouth whenever the electricity was applied. Her physician tells of another case in which the patient could taste the kind of drug used in treating the uterus.

Regarding the latter case the physician writes: "Mrs. H. could distinguish whether I used tincture of iron, iodine, carbolic acid or nitrate of silver, almost immediately upon application to mucous surface. There was an ulcerated and granulated condition of the cervix where I used carbolic acid in treating the ulcer and nitrate of silver in treating the granulations. She would say: 'You have used carbolic acid,' or 'You have used nitrate of silver,' not anticipating it, nor would I think that she would know.

While she was an educated woman she knew nothing about drugs and, as I remember, took no interest only to say, 'You are using such and such a drug and it is so disagreeable.'"

Have any similar experiences been reported?

GENERAL REVIEWS AND SUMMARIES

AFFECTIVE PHENOMENA—EXPERIMENTAL

BY JOHN F. SHEPARD

University of Michigan

No writer on the relation of organic and mental processes has defended a more specific or more invariable correlation than Marston (**8**). He studied the changes in systolic blood pressure caused by an attitude of deceit. He found no significant change of pressure with mere intellectual work. Subjects for the study of deceit were told that a friend had been accused of a certain crime, and a series of incriminating facts were given as established. If the subject chose to try to clear his friend by a lie, he framed an alibi accordingly; if he chose to tell the truth, he selected a marked paper which showed a consistent story written by an assistant, admitting the facts but exonerating the friend. This story was supposed to be the truth. In another set of experiments, the subject received sealed instructions and left the room. If he chose to lie, he opened the envelope, did as directed, came back and lied about it at the examination. If he chose to tell the truth, he did as he liked, came back and told a true story of what he had done. Blood pressure tests were taken before, during and after the examinations. A marked, consistent, gradual rise of blood pressure reaching a climax at a certain point in the story is reported for deceit cases and a tendency toward lowered pressure with truthful accounts. The experimenter on the basis of pressure results, obtained 96 percent. correct judgments as to the truth or falsity of the stories told; while jurors who listened to the testimony did not succeed in judging with much accuracy.

Basing his argument on Cannon's theories, Marston concludes that fear and anger are the only mental processes that can cause moderate rise of blood pressure. Intense joy, sorrow, disgust, or sex excitement may give extreme pressure changes, but only fear and anger show such effects as he found with deceit. He believes

the factor in deceit which influences pressure is fear. Attempted voluntary control of this fear results in a gradual rise to climax, the typical curve. There are numerous possibilities of error in the experiments as published, but it should be added that Mr. Marston, with the coöperation of Drs. Troland and Burtt, has since carried through work in which many of the sources of doubt were eliminated. The matter certainly deserves several thorough investigations.

Robbins (10), in an interesting plethysmographic study of stammering, had occasion to find also the effect of shock (fright) upon the peripheral volume. Both shock and stammering gave marked vasoconstriction. There was a latent period averaging 3.4 sec. after the stimulus. The more intense and the more unexpected the stimulus, the greater and the more rapid the vasoconstriction and the slower the recovery. In response to shock, stammerers on the average showed 70 per cent. greater vasoconstriction than normal speakers, the constriction attained its maximum in two thirds the time of the normal, and the recovery required 23 per cent. more time than normal. Constriction due to stammering continued throughout the period of stammering; and for many subjects and for most shock stimuli, the reaction was not quite so great with shock as with stammering. Aside from temporary fall due to shift of attention when a person begins to read, speech (reading) gave rather vasodilatation than vasoconstrictions in normal subjects.

Hyde and Scalapino (5) found that the minor tones of Tschaikowsky's death symphony caused increased cardiac rate and action current with fall of systolic and diastolic pressure. Toreador's song increased pulse rate, decreased action current, and increased systolic and pulse pressure. Only a beginning has been made with the experiments. The reviewer wishes to suggest that all such studies should use a continuous record showing breathing and as many other factors as possible in detailed interrelation.

Burge and Burge (1) found that great excitement (fright and anger) and activity in cats caused 90 per cent. increase in the catalase content of the livers compared with those of normal cats. This catalase is carried by the blood to the tissues to produce increased oxidation.

Hammet (4) finds glycosuria in approximately 50 per cent. of the cases examined after participating in or observing a football game, and after a difficult written examination. Tests before the

exciting mental process in each case had shown no glycosuria. Most of the effect had disappeared after four hours. He believes urine for medical diagnosis should not be taken immediately after a long physical examination has been given.

Stewart and Rogoff (11), as a preliminary to other experiments, attempted to determine whether fright and other emotional disturbances would exhaust the supply of epinephrin present in the adrenals. Increased liberation of epinephrin would not necessarily imply reduction of the epinephrin store in the glands, and, in fact, it was found that the amount of epinephrin excreted in response to stimulation was not decreased by preliminary frightening. This led to the problem. In the experiments, the nerve supply to one adrenal was cut, all operations being performed under ether anesthesia. Under these conditions, morphine caused relative reduction of the epinephrin supply in the still innervated adrenal in both cats and dogs, but in the cats it was accompanied by symptoms of fright, in the dogs by reverse symptoms. Actual fright or excitement without drugs did not with either cats or dogs cause such relative disturbance of the epinephrin supply in similarly operated animals. Also all the signs of fright could be obtained from an animal in which one adrenal had been removed and the nerves of the other sectioned; this includes dilatation of the pupil on the side on which the superior cervical ganglion had been removed, as well as the normal pupil. During and for some hours after an operation there is a decline in the store of epinephrin in an adrenal whose nerve supply is intact as compared with a denervated adrenal. Infections of various kinds caused marked depletion of the supply in innervated adrenals. Stimulation of the splanchnics increased the amount of epinephrin liberated into the blood, but did not readily reduce the stock of epinephrin in the adrenals. Short periods of stimulation with intervening rest many times repeated, however, gave a decrease.

Two reports by Young are based upon a study of introspective accounts by several subjects. In the first (14) he asks whether pleasantness and unpleasantness can occur simultaneously. A relatively brief stimulus was used to break into a continuous affective situation, or two briefer stimuli from the same or different sense departments were combined or given in alternation, or even a single stimulus was given. Some subjects reported mixed feelings, others did not; and those who did so reported them in sporadic groups. After an analysis of the mixed feeling reports, the writer

concludes that they are all statements about the experience, or statements which attach a meaning of pleasantness or unpleasantness to an object or objects, which express the awareness of an object which usually arouses feeling rather than being a direct setting forth of the experience. This error is favored by intellectualization, fatigue and sleepiness, etc., lack of training in psychological report, suggestion and habituation. Rapid alternations of pleasantness and unpleasantness, affective doubt, and brief interruption of a mood conceived as permanent are also likely to be confused with true mixed feeling. The author concludes that pleasantness and unpleasantness never coexist. Some of the reports said to be cases of "meaning-error" seem to the reviewer merely more or less inadequate descriptions of the sensory content with feeling, which should certainly be allowed in any reliable introspection. The same introspective accounts are used in a second report (15) in which the general method of treatment is similar. The author concludes that pleasantness and unpleasantness are not localizable and show no complicating qualitative differences when regarded independently; that is, abstracted from the sensory content. Reports were demanded of feeling abstracted from the sensory components. The questions of localized feelings and mixed feelings are intimately related.

Tolman and Johnson (13) found that association reaction times in response to words of unpleasant significance averaged distinctly longer than reactions to words of pleasant or indiffernet significance, and this was true of words expressing simple sensory qualities as well as of those referring to deeper emotional experience. Women showed the tendency more strongly than men.

Moore (9) attempts to measure the strength of emotional disturbances by determining their distracting effects in terms of delay in solution of simple arithmetical problems. Fear caused the greatest disturbance, and then in order we find anger, embarrassment before a crowd, sex interest, repulsion. Fear and anger showed a negative correlation. The greatest individual differences were found with anger and embarrassment, least with sex interest and repulsion.

Langfeld presents two studies of the judgment of emotions from facial expression (6, 7). On the whole there was rather unexpected uniformity of judgment. Pain, distress, tormented fear were often seen in place of the more aggressive anger and hate, especially in the milder forms. Expressions of anger suggested fear also to

various subjects and fear suggested anger. Various forms of distrust and of aversion were fairly well judged. In combinations, the stronger emotion usually covered up the subtler. Laughter was nearly always observed correctly. Determination and animosity were readily seen. Most subjects quite regularly made use of kinaesthetic imitation and of association with remembered or imagined situations into which the expression would fit. One group of subjects approximated the supposed correct title of the picture in an average of 32 per cent of. of the cases, and in nearly all of these the correct title was accepted. Of those so accepted, a suggested wrong title was later accepted in 34 per cent. of the total. Of the supposed correct titles which were not approximated in the original judgments, 61 per cent. were accepted when presented, and in 49 per cent. of these a wrong title was accepted when suggested. There were marked individual differences both in the ability to approximate the correct titles in the original judgments and in suggestibility to other titles later; and variations in the one do not necessarily correspond with variations in the other.

A report by Thorndike (**12**) on esthetic appreciation of simple forms, while showing certain proportions most liked and others most disliked, nevertheless emphasizes primarily the extreme individual differences which one finds in all such work.

Children of kindergarten age and college sophomores are used as subjects in an experiment by Dashiell (**3**) on affective preferences of single colors, color combinations, and tone intervals. The most striking result was the small reliability of the children's estimates, the scores showing almost no group preference among the colors or color combinations. Aside from the low reliability, however, it may be noted that the children gave nearly the same order of single colors as the sophomores: blue, red, green or yellow, violet, yellow or green, orange. The children showed a negative tendency toward discords, but of less degree than the sophomores.

To obtain a measure of esthetic judgment of a series of 36 pictures, Miss Washburn and her coworkers (**2**) asked three experts to arrange the pictures in order of merit. The average deviation of the experts in judgments of rank of a particular picture ranged from 7.8 places to .4 of a place, and averaged for all pictures 3.4 places. Women student observers then ranked the pictures. The correlation between individual observer's ratings and the expert ratings varied from 0.82 to −0.42. The combined student ranking correlated with the expert ranking 0.33, p.e. of 0.10. A

subgroup of students of least artistic taste and training showed a correlation with the expert ranking of −0.11. A subgroup of most artistic taste and training gave results which correlated with the expert 0.49. A subgroup with no artistic training but especially interested in pictures gave judgments which correlated with the expert 0.43, nearly as high as those who had also had training.

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ATTENTION

BY W. B. PILLSBURY

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Two articles only have appeared in the literature available on attention this year. Fukuya (1) studied the relative efficiency and speed during strained and normal attention in copying words,

making additions, and learning nonsense figures and symbols. The subjects were ten university students and ninety-six students from various grades in the Chicago schools. The results show practically no difference between the two forms of attention. Some individuals obtained better results in one, some in another, but the differences were on the whole insignificant. This statement applies to speed as well as to accuracy. On the whole active attention gave better results for short periods of work and at the beginning of all work. There was some tendency shown for the young children to be distracted by the demand for extra effort. Lobsien (2) applied Münsterberg's street railway employee's test to twenty children as a measure of attention. It was modified somewhat in detail, mainly by decreasing the number of cards, and increasing the number of danger points. He regards it as a useful test for the purpose, although the results as stated seem somewhat scant for the amount of space taken. The main positive contributions are that there is a high correlation (.84) between intelligence and the results of the tests, and extent and efficiency of attention show an inverse relation.

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SPACE ILLUSIONS

BY HARVEY CARR
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The literature on space illusions is confined to a single study on the Weber illusion of moving compass points (1). Forty-two regions of the body were systematically explored and thirteen subjects were employed. The illusion was obtained in twenty-four of the regions. It occurred more frequently for longitudinal than for transverse directions of movement. With a few exceptions the character of the illusion for any region was the same for all observers. The illusion was correlated with the varying degree of sensitivity of the skin as given by the tables of Weber and Vierordt and as measured by the method of equivalents. A continuous motion of the compass points is a necessary condition and the optimal rate of movement was found to lie between 4 and 12 cm. per sec. The illusion occurs with the congenitally blind and hence visualization is not a necessary

condition. Tests on negro subjects did not permit of any statements concerning possible racial differences. The illusion is influenced by such factors as the ease of localization and the intensity and clearness of the cutaneous impressions. Differences of cutaneous sensitivity and continuity of movement are regarded as the prime conditions of the phenomenon.

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CUTANEOUS SPACE

BY HAROLD E. BURTT

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Goudge (3) reports a study of Weber's illusion, namely, that when two points separated by a constant distance are moved with equal pressure over a cutaneous surface a converging or diverging is felt,—the former when moving from an area of greater to one of less sensitivity and vice versa. Goudge's study was more thorough than Weber's, comprising 42 regions of the body as compared with Weber's 12. A complete study of these 42 regions was made on one observer and those regions which yielded the most interesting results investigated on other observers. The illusion was found in 24 of the 42 regions with a fairly close agreement among different observers. The only notable disagreement with Weber's results was the existence of the illusion when the esthesiometer distance was below the limen for the region studied. Discontinuous movement did not yield the illusion but an impression of parallel lines at varying distances apart. The optimal rate of movement was between 4 and 12 cm. per second. Visualization was not necessary for the illusion but facilitated it, as shown by experiments on congenitally blind. Change in ease of localization (as graded by observers) corresponded with convergence as the ease decreased and vice versa. Considering the traditional order of sensitivity of parts of the body there was, with minor exceptions, a divergence with increase of sensitivity and convergence with decrease. The comparative sensitivity of parts where the illusion occurred was further studied by finding aesthesiometric equivalence ratios. Increases in these ratios on neighboring regions corresponded with convergence in the illusion. Finally the essential factors in the

illusion seem to be "difference in sensitivity of the cutaneous surface, and continuous movement of the two-point stimulus."

Friedline (2) attempted by systematic study of the volar distal forearm with subliminal stimuli to reconcile some of the controversies in the esthesiometer experiment. In each series two subliminal distances were used. They were first presented nine times each for practice and the subject then tried to recognize the two when presented in chance order. Any description of the pattern observed such as "line, dumb-bell, paddle, oval" was noted. The results seem to fall into two classes, those in which the experiment failed and those in which the subject made upwards of 80 per cent. correct judgments. The latter alternative was the more frequent. Various factors were noted which tended to derange the experiment: fatigue, physical condition, after images, emotional state, suggestion, temperature of the cast in which the arm rested, and extraneous noises. The results throw light on the disputed question of reduction of the limen by practice. Discrimination was often very greatly increased by change in the attitude toward the stimulus, *i.e.*, it was felt and recognized as a pattern or object. Improvement due to this shift in attitude is not the same as sheer reduction of the limen by practice. With reference to the supposed raising of the limen by fatigue, the experiment shows that much depends on the initial determination of the limen. If this happens to be a slightly subliminal pattern, fagitue would make its recognition impossible (*cf.* the two distinct alternatives above noted); whereas if the start was made with the two points clearly differentiated such fatigue would make little difference.

Curtis (1) studied the advisability, in using the two point threshold for anthropological purposes, of giving only one trial to each of a large number of individuals. An esthesiometer distance of 4 cm. was applied once to each of 444 persons ranging from superior adult to feeble minded. A much larger per cent. of the normal group than of the abnormal gave a "two" judgment, and a similar difference is found when the subjects are grouped by mental age. The method of one trial is recommended because it is possible to test a larger sampling, and because errors due to change of attitude and practice do not occur.

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GRAPHIC FUNCTIONS

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A summary of the work on handwriting scales inclusive of their organization, various applications, and the school surveys made possible by them is now available in book form, respectively by Monroe, DeVoss, and Kelly (**8**) and by Starch (**10**). Starch's résumé includes also material of general psychological interest as well as that pedagogically valuable. The detailed report on his new handwriting scale, Starch presents in another connection (**11**) This scale is constructed on the principle of judgment of general merit or excellence of quality and the values of the steps are determined with a high degree of accuracy. In this respect it is standardized with greater care than scales constructed prior to it. It also embodies a number of practical features. Other recent scales include those sent out by Zaner and Blossom (**12**) and by the Bureau of Research and Efficiency, Kansas City, Mo. (**3**). A new form of the Ayres Scale, the Gettysburg, edition, is cited. Breed (2) concludes from an experimental investigation that this form of the scale is somewhat more accurate than the older three-slant form.

An interesting departure from the more common reports is found in Koos' attempt to determine ultimate standards of quality in handwriting by an investigation of the standards of attainment actually achieved by various occupational groups (**7**). This determination is effected through a rating on the Ayres Measuring Scale for adult writing of specimens of non-vocational correspondence written by 1,053 adults in various walks of life. The average quality of the 1,053 specimens is 49.5 on the scale. But some interesting differences between groups is evident, for example, the high average quality of writing among clubwomen and engineers, and the low average for lawyer, physician, writer, clergyman, and musician. If, as Koos assumes from data at hand, the quality of handwriting does not greatly deteriorate after acquisition, an interesting problem is suggested concerning mental types and quality of handwriting, a point of attack which seems to the reviewer

a most promising one. The quality of handwriting needed for social correspondence Koos determined by a tabulation of the judgments of 826 adults as to adequate penmanship for social correspondence. It would seem that 50 on the scale is adequate. For vocational uses 60 may be set as the standard, with 70 as the attainment needed by some occupational groups.

The relation of left-handedness and mirror-writing receives some new light from the questionnaire study of it reported by Beeley (1) in his study of left-handedness. It is to be regretted that the finger-tapping test, cited as valuable in the determination of handedness, was given to so small a number of the mirror-writing children, since such a test would have served to check the reports as to degree of handedness, reports which are subject to considerable error. An interesting section of the monograph concerns itself with the methods used by teachers in getting mirror-writers to adopt a more conventional style of writing.

The utilization of handwriting in character-diagnosis has not been attempted to any degree by psychologists, in spite of the pioneer work by Binet, therefore particular interest attaches to the experiment by Hull and Montgomery (6) who tested a few traditional assumptions of graphology by obtaining the correlational coefficients for two orders of merit; one based on objective measurement of graphic traits; the other, on judgments upon character traits made by intimate associates. The correlations of heavy pressure with forceful personality; upsloping lines with confidence or ambition; fine tracery with bashfulness; perseverance with long t-bars; reserve with closed a's and o's, are tested out but with negative results.

A somewhat similar investigation by Downey (4) gave inconclusive results with respect to a number of graphological assumptions but yielded evidence of positive correlation between preoccupation with details and small filiform writing, and also between an explosive or inhibited psychic make-up and the general graphic pattern.

In *Graphology and the Psychology of Handwriting*, Downey (5) disentangles the basal concepts of graphology; discusses the various methods the graphologists have employed in working out their system of character analysis; and tabulates in parallel columns the conclusions of the graphologist, the handwriting expert, the pathologist and the experimentalist concerning such graphic elements as size, slant, alignment, line-quality, continuity, and proportion.

In the experimental section of the book the author discusses handwriting disguise, variations in handwriting under stated emotional conditions, the relation between handwriting individuality and expressive movements, and reports a graphological study of the handwriting of a group of well-known psychologists.

Monteith (9) in an article on automatic writing that is spiritistic in import cites two varieties of such writing that should be further analyzed by the scientist. These varieties are: 1, the strictly automatic "where hand or forearm is temporarily paralyzed and devoid of any feeling while the power of writing is retained; and, 2, the inspirational or intuitional, when the automatist becomes mentally aware of the substance of the communication before the hand moves at all."

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SPECIAL REVIEWS

Psychology and Preaching. C. S. GARDNER. New York: Macmillan, 1918 Pp. viii + 389.

This volume is an attempt to apply the results of modern psychology to the function of preaching. Each of the first ten chapters deals with a particular psychological process and indicates its significance for the uses of the minister. The treatises of the best authorities are summarized with reference to instinct, imagery, feeling, sentiments, belief, attention, voluntary action and suggestion, and application made to the preacher's task of understanding and persuading men. Other chapters deal with Assemblies, Mental Epidemics, Occupational Types and The Modern Mind.

It is a sane, well-written work and contains little from which either the psychologist or the minister is likely to dissent. At the same time neither will be greatly illuminated by it. The psychology may be obtained in more satisfactory form from the authorities cited and the deductions for the art of preaching are not marked by novelty or liveliness. It is doubtful whether the attainment of persuasive public speech can be greatly facilitated by such a treatment of the subject. More valuable material for certain phases of the study might be found in the writings of the social psychologists, such as Charles H. Cooley.

The author rightly emphasizes the voluntaristic trend in psychology and in practical religious interest. The chapter on Occupational Types deals convincingly with the minister himself, the wage-earner, and the business man. The last is keen and alert, of limited intellectual range, practical, non-mystical, unsectariarian. "Under the dominance of this type of mind we are witnessing a most interesting and important double development in Christianity—theological disintegration, on the one hand; and on the other, integration around practical enterprises of the great religious groups, originally organized on a basis of theological differences." The business men are said to constitute the most influential group in the local churches, and therefore the minister should understand their characteristics and shape his message to reach them as well as the more academic auditors.

E. S. AMES

The Mental Capacity of Savages. E. FARIS. *Amer. J. of Sociol.*, 1918, **23**, 603–619.

Faris discusses in an interesting way the mental characteristics

of savages with reference to a Bantu tribe of the Upper Congo, among whom he has lived. In agreement with Boas and others, he deprecates the traditional belief in the inferiority of savage races. After enumerating and illustrating six sources of error often committed when passing judgment upon such peoples, he sets forth various observations which either indicate a high degree of mental ability (the complex structure of language, for instance) or refute commonly accepted opinions (the superior sensory acuity, sense of direction, and emotionalism of the savage, his imitativeness, etc.). The author's remarks upon the alleged intense emotionalism of uncivilized races are especially worthy of attention. In his opinion the emotionalism displayed by the American negro in his religion, does not necessarily indicate a high native susceptibility to emotion or a lack of rational control. The negro's extravagance can be matched in the white race that was the teacher of the black—in the white camp-meetings of the South, for instance; and in such revivals as those of Kentucky, in 1803. If under the influence of certain forces, these practices have disappeared among the whites, the same forces when felt by the negro, result also in a decreased emotionalism. The author has observed among the Bantus three distinct types of Christianity, none of them emotional to any marked degree. "Their reaction to Christianity has taken a form decidedly theological, and they can argue and debate like any one of our modern polemic sects." His opinion is that the American negro got his emotional religion from emotional white Christians, while the Bantus got their "intellectual" religion from a non-emotional type of Christians.

The paper ends with a plea for a scientific study of the mentality of savage races, with the help of the exact methods (tests) now in our possession.

JAMES H. LEUBA

The Validity of Religious Experience. G. A. BARROW. Boston: Sherman, French, 1917. Pp. 247.

This is a course of lectures delivered at Harvard University. A review of them hardly falls within the field of the BULLETIN, for the author is concerned "not with questions of fact, but of meaning." The analysis he proposes to make is "the philosophical analysis." The conclusion of the discussion is that the source of religious experience is super-individual, superhuman, and personal.

JAMES H. LEUBA

NOTES AND NEWS

PROFESSOR DANIEL STARCH, of the University of Wisconsin, is on leave of absence for the first half of the present year, to give courses at Harvard University.

PROFESSOR G. M. WHIPPLE, of the Carnegie Institute of Technology, has been appointed professor of experimental education in the University of Michigan.

DR. HARRY D. KITSON, instructor in psychology at the University of Chicago, has accepted the position of professor of psychology at the University of Indiana, vacant because of the election of Professor E. C. Lindley as president of the University of Idaho.

DR. W. W. CHARTERS, of the University of Illinois, will assume charge of the research bureau for retail training at the Carnegie Institute of Technology. In the same institution Dr. Kate Gordon has been promoted to an associate professorship in the division of applied psychology, but will be absent part of the year to conduct investigations for the California State Board of Charities. Professor C. S. Yoakum has been promoted to the directorship of the bureau of personnel research, with Dr. W. D. Scott as associate director (part time).

DR. E. G. BORING, of Cornell University, has been appointed professor of psychology in Clark University, to succeed the late Professor J. W. Baird.

THE following items have been taken from the Press:

MR. J. C. FLUGEL has been appointed lecturer in psychology at University College, London.

PROFESSOR D. S. HILL, of the University of Illinois, has been elected to the presidency of the University of New Mexico.

PROFESSOR NORMAN KEMP-SMITH, professor of philosophy at Princeton University, has been appointed professor of logic and metaphysics at the University of Edinburgh.

PROFESSOR W. S. FOSTER, has been appointed professor of psychology at the University of Minnesota.

DR. L. S. HOLLINGWORTH, of Teachers College, New York, has been promoted from an instructorship to an assistant professorship.

PROFESSOR J. DEWEY, of Columbia University, will be engaged in educational work in China during the year.

DR. EDWARD COWLES, well-known for his work with the insane as superintendent of the McLean Hospital, has died in his eighty-third year.

A GRANT of $6,000 has been made to the psychological laboratory of the Johns Hopkins University "for investigating the informational and educative effect upon the public of certain motion picture films used in various campaigns for the control, repression, and elimination of venereal disease."

DR. E. H. HAECKEL, professor of zoology at the University of Jena, has died at the age of eighty-five years.

PROFESSOR D. B. LEARY, of the department of education of Tulane University, has been appointed professor of psychology at the University of Buffalo.

A PROPOSAL to establish an institute of commercial and industrial psychology and physiology in Great Britain is announced. The project has the support of many eminent British physiologists and psychologists.